Recovery through Videogame Play - the Role of Mental Workload

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Abstract

Playing games has been shown to be an effective method of post-work recovery. Previous research has shown that gameplay with high cognitive involvement is effective for recovery. This finding conflicts with models of mental workload (MWL), which suggest that people feel best when cycling between high and low MWL. To unpack the relationship between recovery and mental workload, we designed a lab experiment where 40 participants experienced different combinations of high and low MWL while undertaking both work tasks and recovery gameplay, and we collected both self-report and physiological (fNIRS) data. Results showed that high and low MWL games created different impacts on recovery, depending on the MWL of the prior work task. While fNIRS measurements of MWL varied as expected during work tasks, experience of MWL when playing games was not evident in the prefrontal cortex. We conclude by discussing the relationship between mental workload and theories of recovery.

CCS Concepts

• **Human-centered computing → Empirical studies in HCI**.

Keywords

recovery, gameplay, mental workload

ACM Reference Format:
Linqi Zhao, Michael Thomas Knierim, Max L. Wilson, Patrick Dickinson, and Horia A. Maior. 2025. Recovery through Videogame Play - the Role of Mental Workload. In *Proceedings of (CHI '25 Workshop on Envisioning the Future of Interactive Health).* ACM, New York, NY, USA, 3 pages.

1 Introduction

When employees face specific job demands, they may exhibit short-term psychological stress symptoms, manifesting as a negative state (e.g., anxiety, fatigue, and low mood). The effects of work-related stress on well-being, performance, and health have been the subject of many decades of research [2]. In recent years, there has been increasing interest in understanding the recovery process, which is described in the literature as "unwinding and restoration processes during which a person's strain level that has increased as a reaction to a stressor or any other demand returns to its prestressor level" [15]. Specific recovery activities (e.g. physical exercise [5]) and recovery experiences (e.g. psychological detachment from work) can help alleviate these symptoms [14]. Recently, there has also been a growing interest in understanding how playing video games can promote recovery (e.g., [6]).

Workers' experience of recovery can vary between and within recovery activities. Previous work by Sonnentag and Fritz [13] classified recovery experiences using four dimensions: psychological detachment from work, relaxation, mastery, and control. Psychological detachment implies refraining from work-related thoughts and gaining mental distance from one's work during non-work time. Relaxation refers to the experience of low sympathetic activation that can be achieved by meditation or breathing practices, as well as everyday activities that calm the body and mind. Mastery refers to the experience of growth, for instance, by successfully coping with challenges and undergoing learning experiences. Control implies some degree of self-determination and agency in deciding what to do during non-work time and how to do it [8]. These components of recovery can be used to better understand the effects and effectiveness of recovery activities [12].

Whilst relatively little work has thus far looked at games as a means of recovering from work, previous authors have noted a resonance between key characteristics of gameplay experiences and Sonnentag and Fritz's four proposed dimensions of recovery [13]. For example, Reinecke [9] highlights that due to their highly immersive properties, video games have significant potential to facilitate psychological detachment and relaxation. As previously mentioned, aspects of the dimensions of recovery, specifically mastery and control, resonate with concepts of intrinsic motivation which are prevalent in games user research, and rooted in self-determination theory [18]. Reinecke also highlighted the suitability of games to facilitate these types of recovery experiences [9, 11], and argued that gameplay as a recovery activity can help individuals recover from work stress.

Although there is continued debate about the comparative effectiveness of video games on all four aspects of post-work recovery experience, subsequent research (both surveys and laboratory

CHI '25 Workshop on Envisioning the Future of Interactive Health, Yokohama, Japan

studies) continue to report the general applicability of games as a recovery activity [10]. In our recent work [21], we investigated the use of gameplay for recovery through the lens of mental workload (MWL). MWL has been previously studied as an aspect of user experience in the context of both work (e.g. [7]) and games, as a dimension of difficulty and challenge (e.g. [20]). Our study was motivated firstly by initial work by Wulf et al. [19], which showed that varying cognitive demand during gameplay can support different types of recovery experiences, and secondly by the observation that different types of work experiences can predict different recovery activities among workers [15]. Thus far, we explored the interplay between cognitive demand experienced during work tasks and that experienced during recovery. Our work seeked to understand how MWL experienced across the work-recovery cycle influences recovery outcomes from gameplay, and whether MWL during gameplay experiences could be manipulated to support more effective recovery.

2 Methods

We conducted a laboratory study using a 2×2 factorial design with one between-subjects factor (Level of MWL of work tasks) and one within-subjects factor (level of MWL of recovery gameplay). Inspired by similar previous laboratory-based studies (e.g., [10]), we firstly created the need for recovery and evaluated the subsequent recovery experience. We chose to use an audio transcription typing task to represent a work task to generate a need for recovery. We used a version of the classic arcade game Pac-man as the recovery task. For both transcription and game task, seven difficulty levels were created. Our 2×2 design comprised four study conditions: high/low demand work followed by high/low demand recovery gameplay (CHH, CHL, CLH and CLL).

Forty participants (N = 40) were invited to the study, and they were all regular videogame players. Individual participants will often experience different levels of workload when performing the same task, due to individual skills and prior experience (e.g. game playing). We therefore wished to set personalised, calibrated levels of high and low workload for each participant, for both the work task and recovery game. Hence before the formal experiment, participants were invited to practice both transcription task and game task from level 4 (which was the medium objective difficulty level). Based on participants' performance and subjective feelings, we adjusted difficulty levels for them and decided which should be the hard level for each participant. The level 1 of both transcription and game task were used as the low demand tasks.

In the formal experiment, participants were arbitrarily assigned to either the high demand or low demand work task (between subjects factor), and then completed both gameplay conditions (high demand and low demand recovery): either CHH and CHL, or CLH and CLL, where gameplay was counterbalanced. Participants completed their work task (either high or low demand), for 20 minutes, completed the post-task questionnaires, and then had a 30s break. They then played the game (either high or low demand) for 10 minutes, followed by the post-game questionnaires. Participants then repeated this sequence, playing the game with the other demand level. We measured participants' MWL (using the NASA-TLX [4]) and energetic arousal (using the ADACL [17]) after each task. After each game task, we used an additional questionnaire (REQ [13]) to assess their recovery experience. During the whole experiment, participants' brain activation in prefrontal cortex were measured using the functional near infrared spectroscopy (fNIRS).

3 Results and Conclusion

Our work identified several key findings: 1. fNIRS can effectively differentiate the MWL experienced by participants during work and play; 2. The level of MWL influences the participants' energetic arousal and recovery levels post-work and during gameplay; 3. The activity of the prefrontal cortex measured by fNIRS is significantly correlated with recovery experiences. These findings indicate that physiological measurements using fNIRS could help players intuitively understand their recovery needs after work and understand the recovery dynamics in their daily gameplay activities. Indeed, wearable and portable fNIRS technology is primarily applied in various scenarios to monitor workload [3] and dynamically adjust tasks based on monitoring results [1]. In the context of game-based recovery after work, we believe that incorporating fNIRS measures into work and gameplay could potentially have a positive impact on players' strategy formulation (similar to optimizing immersion experiences as suggested by Mella et al. [6]). This integration could enable players to have more control over their recovery experience.

Additionally, our results show that: 1. Playing challenging games post-work offers better psychological detachment; 2. Regardless of work demand, players always gain more mastery by playing high demand games; 3. Playing challenging games after work can lead to a better overall recovery experience. This phenomenon may be due to high MWL games that provide a more appropriate level of challenge. In our study, the criteria for high MWL games were set to offer participants a sufficient challenge that was achievable without being overwhelming. We consider this to be a setting that balances between challenge-skill and slight overload. This level of challenge is thought to be crucial for achieving a positive gameplay experience, fostering immersion and mastery.

Based on our findings, we proposed a model illustrating the relationship between MWL and post-work recovery gameplay (for details see [21]). In this model, we posit that the primary difference between the impacts of game MWL and work MWL on recovery may stem from the inherent nature of these tasks. Compared to work, gameplay features a low duty profile [16] (i.e., a reduced sense of real-world responsibility during gameplay), which is why playing can replenish mental resources depleted by work. Therefore, MWL in gameplay, which presents more of a challenge than a hindrance, may significantly exceed the negative aspects typically associated with MWL related to work. Within the context of the model we propose, sufficient MWL with less frustration may be the optimal conditions for games to aid players in recovering from work. From the perspective of gameplay experience, appropriate challenges can induce immersion among other positive gameplay experiences, suggesting that positive gameplay experiences may also constitute positive recovery experiences.

Our lab study has several limitations. The participants invited were all videogame players, who might enjoy gameplay more than the non-videogame players. Though gameplay helps gamers effectively recover from work strain, it's possible that non-gamers benefit less from gameplay. Future studies should consider the effects on non-gamers. The duration of recovery game session is another limitation of our study. Our ten-minute game setting referred to settings in similar lab studies, but we need to admit that 10 minutes may not be the most ideal choice. It would be interesting to explore the effect of game length on post-work recovery experience in the future.

Our study has contributed to the understanding of the use of games for work recovery, using the lens of mental workload (MWL). Our findings indicate that recovery experiences are influenced both by the MWL experienced during play for recovery, but also during work. In particular, we found that the level of MWL during play contributed to psychological detachment, mastery, and overall recovery experience. Overall, our findings suggested that games with high MWL are more beneficial for post-work recovery than those with low MWL. Based on these findings, and our discussion, we have proposed a model for the relationship between MWL and recovery experience. We also used functional near infra-red spectroscopy (fNIRS) to monitor changes in participants' prefrontal cortex activation during work tasks and gameplay. Correlations between brain activities and recovery experiences were found, which suggest the potential for brain activation data to be used as a measure of recovery in future studies. Finally, we suggest that future research on using gameplay for recovery experiences should consider the demand features of both work and play experiences, the various dimensions of recovery, and the nuanced interactions between them. Understanding these relationships may help further reveal the mechanisms of post-work recovery and enhance the efficacy of recovery strategies.

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